REMARKS/ARGUMENT

In the Office Action of February 27, 2004, the Examiner has objected to FIGURE 1 and 2 and to claims 1 and 13 and has rejected claims 1-26 under 35 U.S.C. § 103(a). Applicants herein respectfully submit new sheets of FIGURE 1 and 2. Applicants also respectfully cancel claims 1-26 and submit new claims 27-39 for consideration.

Drawings

The Examiner has objected to FIGURE 1 and 2 due to the small axis labels on the graphs. Applicants herein respectfully submit new sheets of FIGURE 1 and 2. The new sheets are identical in content to the original sheets and have only been enlarged. No new matter has been added.

Claim Objections

The Examiner has objected to claims 1 and 13 due to a misspelling. Applicants have cancelled these claims and respectfully submit that the objection is rendered moot by the new claim language in claims 27-39.

Claim Rejection – Section 103

The Examiner has rejected claims 1-26 under 35 U.S.C. § 103(a) as being unpatentable primarily over U.S. Patent No. 6,137,896 to Chang et al. (herein the "Chang patent") in view of the article Belhumeur et al., "Eigenfaces vs. Fisherfaces: Recognition Using Class Specific Linear Projection," IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 18, No. 7, July 1997 (herein the "Bellhumeur article").

Applicants herein cancel claims 1-26 and submit new claims 27-39. The new independent claims are claim 27 and 34. Applicants respectfully submit that the new claims represent patentable subject matter and render the Examiner's rejections and objections moot. No new matter has been added.

As recognized in the background section of the present application at pages 1-2, the general notion of representing a 3D object under different illuminations as being one of many

images in a linear subspace of a higher dimensional surface is prior art. What the prior art does not provide, however, is an analytical representation of complex variations in lighting. As discussed in the background section:

> [F]or more complex sources of variation researchers have collected large sets of images and performed Principal Component Analysis (PCA) to build representations that capture within class variations and variations in pose and lighting. PCA is a numerical technique that finds the linear subspace that best represents a data set. Given a large set of images, PCA finds the low-dimensional linear subspace that fits them most closely.

Specification at page 1. PCA is a numerical methodology that relies on the accuracy of the image samples used to generate the linear subspace. The Belhumeur article, for example, discloses the known use of PCA for dimensionality reduction of an image space. The Belhumeur article, in fact, is directed to an alternative numerical methodology to PCA that specifically selects linear projections that avoid regions of the image that may deviate from the linear subspace assumption.

The present invention, on the other hand, is directed to an alternative to techniques such as PCA or the one disclosed in the Belhumeur article. The present invention takes advantage of an analytic representation of a linear subspace by what the inventors refer to as "harmonic images." As discussed in the detailed description at pages 20-21:

> One advantage of an analytic description is that this provides an accurate representation of an object's images, not subject to the vagaries of a particular sample of images. A second advantage is efficiency; a description of this subspace can be produced much more rapidly than PCA would allow.

Specification at pages 20-21. See also Specification at pages 21-22. The present invention operates more efficiently and rapidly than prior art methods, and operates without complex iterative optimization techniques necessary in prior art approaches.

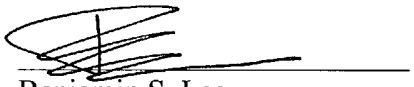
The definition of "harmonic images" is provided in the specification at pages 19-20 and an example of nine harmonic images is shown in FIGURE 3. The notion of "harmonic" lighting and generating the images from the harmonic reflectances is described in further detail at pages 16-19. The situation where four harmonic images are used as a basis for a linear subspace provides some analytical simplification that is further described at pages 25-29.

Accordingly, claims 27 and 34 now recite that a "set of harmonic images" are generated for a three-dimensional model of a candidate object, the "harmonic images forming a basis for a linear subspace and approximating a reflectance on the candidate object when illuminated by a harmonic light". Then a candidate image is constructed using the "harmonic images" as basis images for the linear subspace. None of the references cited by the Examiner in the Office Action disclose or suggest these limitations.

Moreover, claims 28 and 35 recite the limitation that the candidate image is constructed from "harmonic images" "restricted to a subset of the linear subspace that corresponds to physically realizable lighting conditions." Again, none of the references cited by the Examiner in the Office Action disclose or suggest this limitation.

Applicants respectfully submit that the application is now in condition for allowance. If the Examiner has any questions, please contact the undersigned at 609 951-2522. Authorization is hereby given to charge any fees which may be required, except the issue fee, to Deposit Account 14-0627.

Respectfully submitted,



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